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U.S. Department of Agriculture Agricultural Research Service

October 1982

Agricultural Research

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The Mission of the Agricultural Research Service

A Federal responsibility for agricultural research has been a part of USDA's mission from the start. In the course of its 140-year history, the Department's research mission has been shaped by changes in the Nation's agricultural needs, population growth, evolving technologies, and Federal policies.

Now, at the start of the 1983 fiscal year, we are once again examining the Department's research mission as carried out by the Agricultural Research Service. Knowledge of current trends allows research planning to anticipate agriculture's needs as we approach the 21st century. And current and emerging technologies are bringing to light important research opportunities.

These opportunities fall into four general areas:

- Conservation, reclamation, and efficient use of the natural resources needed for sustained agricultural production;
- Increase in the long-range productivity of animal and crop production systems;
- Increase in the efficiency of processing, distributing, and marketing food and agricultural products to users, and
- Maintenance and improvement of systems to provide people with food that is safe and of high nutritional and esthetic quality.

These research challenges clearly call for ARS's team approach. The problems facing agriculture do not come in neat and tidy packages. Animal and plant diseases know no boundaries. Soil and water conservation research requires the coordinated expertise of hydrologists, soil scientists, physicists, plant physiologists, engineers, and many other disciplines. The concerns of postharvest storage losses, pest management, and human nutrition each require expertise in equally diverse areas of knowledge.

The Secretary of Agriculture and the Office of Management and Budget have charged ARS to place maximum priority on research areas of high potential and high risk. We are to stress areas that cannot or will not be addressed by industry or state experiment stations.

At the same time, we know that ARS works within a vast agricultural complex that produces, processes, and delivers products in the United States and around the world. Our research is far from being isolated.

These forces have forged ARS's mission as we begin the 1983 fiscal year. Our role is to:

- Address problems that are of legitimate national concern,
- Conduct research that is appropriate for the Federal Government, and
- Exploit the unique capabilities of ARS scientists and the facilities they operate.

This combination forms a united and coordinated national resource that is not duplicated by others in the full U.S. agricultural research and development system.

More specifically, ARS conducts research that is—

- National in perspective in that it focuses on significant problems affecting the entire Nation or its several broad geographic areas;
- Sufficiently long-range, high-risk, and of such broad scope as to require the unified planning, continuity of effort, and stable scientific environment maintained by the Federal research organization;
- Not undertaken by other agricultural research institutions because of their narrower geographic focus or shorter term perspective; and
- Uniquely a Federal responsibility in that it

— is requested by Congress or the executive branch and requires special skills, facilities, or capabilities of ARS;

— requires a structure ready to respond to emergency situations of regional and national significance;

— is international in nature, supporting foreign policy initiatives of the U.S. Government;

— supports the development and maintenance of important national collections that are essential to scientific activities; or

— supports Federal action programs.

The enviable record of U.S. agriculture is a tribute to the generations of scientists who have contributed to every area of research included in their mission. Although specific objectives in that mission have changed through the years and will continue to change, the permanent mission of ARS will always be to anticipate and meet the changing needs of agriculture.

Terry B. Kinney, Jr.
Administrator, ARS

World Food Day, 1982

World Food Day observances in October spotlight the United States' role in providing food and technical assistance to developing nations. Sponsored by the United Nations, World Food Day marks the anniversary of the founding of the Food and Agriculture Organization (FAO) on October 16, 1945.

Since the midfifties alone, the United States has provided 283 million metric tons of farm commodities valued at $30.3 billion to 164 nations and territories.

ARS scientists, in cooperation with the total Federal and State agricultural community, have contributed significantly to this effort, participating in international assistance and exchange programs for many years.

In working with development agencies such as the Agency for International Development, FAO, and the World Bank, ARS and other USDA-funded scientists are providing on-the-spot assistance to some 50 nations in Asia, Africa, and Latin America to develop their research and production capabilities.

In other programs, such as the foreign research associate/visiting scientist program, scientists from other nations work, study, and visit ARS facilities and the facilities of other Federal and nonfederal agencies to encourage self-help in food production.

Among projects being studied by foreign scientists at ARS research facilities are: synthesis and applications of new chemicals for insect pest management, mycotoxin contamination in grain, structure of corn proteins, effects of growth modifiers on various crops, development of winter wheat, and isolation and determination of steroids.

In addition, at the ARS facilities, foreign scientist trainees are learning techniques with radioactive compounds used with carbamate insecticide in plants, receiving training in computer models of agricultural pests, and gaining practical application of pheromones in combinations with traps and other control measures.

At the eight overseas ARS research laboratories, ARS scientists, through other programs, are working cooperatively with local government and university scientists. Overseas laboratories are located in Argentina, France, Italy, Japan, Kenya, the Netherlands, Thailand, and Guatemala.

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Science and Education

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Cover: A black cutworm feeds on a young corn stalk. An ARS scientist is developing a system to monitor the northward journey of black cutworm moths in early spring. Projecting the appearance of the destructive larvae in corn fields could improve control measures, which must be precisely timed in order to be effective. Story begins on p. 4. (0782X744-9)

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The Biography of an Insect Assassin

A musk thistle head weevil prepares to lay its eggs on the flowerhead of a musk thistle plant.(0682W639-15)

"As a weed scientist, I often hear or read the statement: 'All you have to do is release an insect or pathogen that will attack and control the weed pest.' As you can see in the case of the musk thistle, that *isn't* all you have to do."

So says John J. Drea, Jr., ARS research program leader for biological control of pests, speaking of a successful musk thistle control program that has spanned two decades and involved two continents.

Weed scientists are confident of ultimate control of musk thistle (*Carduus theormeri*) in this country because of a small weevil about ¼-inch long which feeds exclusively on the plant. Released at many locations in the United States starting in 1969, the musk thistle seed or head weevil, *Rhinocyllus conicus,* lays its eggs at the base of developing musk thistle flower heads. Larvae then hatch and bore into the head, where they feed and prevent most or all seeds from developing.

"We are confident about ultimate control, yes," Drea says. "However, we are still faced with challenges and some setbacks. Research in Nebraska shows that the musk thistle produces more seeds over a much longer period than we first recognized. And weather has been shown to adversely affect weevil egg laying."

Drea is referring to ARS research led by M. K. McCarty in Nebraska, which shows that the musk thistle produces viable seed over a period of 7 to 9 weeks, twice the time previously accepted. McCarty's research also showed the average musk thistle plant can produce enough seed for more than 3,800 potential musk thistle seedlings.

This phenomenal prolificacy was observed particularly in the wet fall of 1978, McCarty says, resulting in unusually high germination. Prior to that, Nebraska experienced a series of dry falls so that the weevil's controlling effect looked more promising than now.

"Egg laying by the adult weevil is triggered by temperature," McCarty says. "Several hot, muggy days in a row, as in 1978 in Nebraska, causes the weevils to lay eggs too rapidly on too few flower buds. As a result, many seed heads that were formed later were not visited by weevils." McCarty feels that other species of plant-feeding insects are needed in combination with *R. conicus* to attack the thistle during other stages of growth.

In Montana, cooler spring temperatures cause weevils to extend egg laying more completely over the period of flowering. As a result, according to research entomologist Norman E. Rees, Bozeman, the weevils have reduced the musk thistle population in the state's Gallatin Valley to about one-fifth of the 1974 infestation.

Rees has observed two deterrents to the weevil's effectiveness in Montana. First, severe moisture stress to the plant during extended dry periods causes death of the larvae. Second, pasturing cattle in the field during the period of weevil egg laying causes the weevils to leave the field and seek thistles elsewhere.

"We will add diversity and intensity to musk thistle suppression this summer (1982) by including a second weevil, *Trichosirocalus horridus,* in our studies. Its larvae feed in the crown or center of the thistle rosette," he explains.

L. T. Kok of Virginia agrees with Rees and McCarty that a second weed assassin is needed. An entomologist at Virginia Polytechnic Institute and State University, Kok says a survey of Virginia pastures in the early 1970's found more than 150,000 acres to be heavily

infested with musk thistle as part of a substantially greater total infested acreage.

Kok says it took on the average 3 years for *R. conicus* to colonize in Virginia and another 5 to 6 years to multiply to the point of control. "It is now established in most musk thistle areas of Virginia, but it needs support from a crown feeding weevil." His choice for the support role also is *T. horridus*.

In the northeastern states, musk thistle is a problem where shallow soil covers limestone—western Maryland, central and eastern Pennsylvania, and parts of western New Jersey. Entomologist Suzanne Batra, Beltsville, Md., has released *Rhinocyllus conicus* along highways in these areas. Highway departments are willing to cooperate in releasing the weevil because musk thistles have crowded out the crown vetch planted on steep banks for erosion control.

The seed weevil is well established in these areas and has reduced thistle seed production to about 50 percent of the 1976 levels, according to Batra. To supplement the control by the seed weevil, the crown-feeding weevil, *T. horridus,* was released this year.

These research findings support Drea's statement that finding and establishing an insect assassin is neither a speedy nor a totally finished process. Depending upon the geographic location and weed habitat, scientists say several years or a decade or more may elapse for an insect enemy to colonize and establish itself to the extent it begins reducing the problem. And Drea stresses that herbicides are still needed during the lengthy period of weevil establishment, as well as for occasional problematic or isolated infestations.

The first musk thistle was described for the literature more than 200 years ago by Carolus Linnaeus, the Swedish botanist who developed the system used internationally for classifying plants and animals.

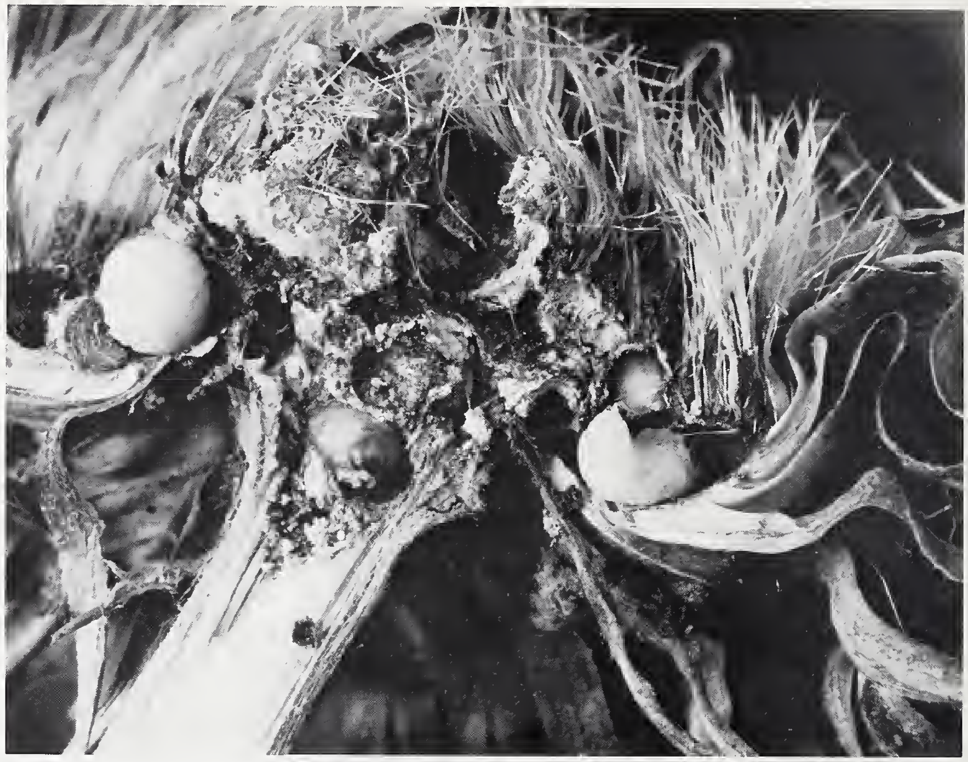
The musk thistle was introduced to this country from southern Europe more than 100 years ago—without its natural enemies. It attracted little attention until the 1930's, when it began spreading rapidly. It is now established

Entomologist Suzanne Batra checks musk thistles for egg masses laid by the weevil. Musk thistles can grow to more than 8 feet in height, and can quickly overrun pasture land. (0682W637-20A)

in 40 states. The primary species in the U.S. is *Carduus theormeri. Carduus nutans,* similar in appearance and behavior to *C. theormeri,* occurs in limited areas of the northeastern United States and Canada.

Musk thistle is one of the most difficult weeds to control. It reproduces by seed—up to 1,500 per head—and the seed can lie dormant in the soil for years. Once a stand is established, pasture land is literally laid waste by the weed. Cattle not only do not eat thistles, but also will not reach for edible plants growing near them. Herbicides can be applied effectively in the spring or fall, but that is when farmers are busy with planting and harvests. And, costs of herbicides and application may exceed what the land will return.

The search for an insect assassin to control the thistle began in the 1960's, when Canadian and USDA scientists in cooperation with colleagues in Europe went to the plant's probable source in southern Europe to seek the natural enemies that control it there.



Weevil larvae bore into a musk thistle flowerhead and prevent seed development. One undamaged flowerhead can produce enough seeds to start 3,800 seedlings. (0682W638-17A)

ARS research entomologists Lloyd A. Andres, Paul H. Dunn, and Kenneth E. Frick found 93 different species of insects feeding on musk thistle. They and other entomologists then eliminated 84 of these insects from further consideration because the insects also damaged or were associated with plants of economic importance, such as artichoke.

Among the nine remaining plant-feeding insects, the musk thistle head weevil was determined the most promising and underwent extensive research to assure it would not itself become a pest. Tests at the Biological Control of Weeds Laboratory, Albany, Calif., for example, showed that the weevil does not damage artichoke. Larger populations were then imported from Europe for test releases in Montana and Virginia in 1969.

Four others of the nine remaining species are still undergoing study in preparation for using them as backup biocontrol agents as scientists McCarty, Rees, and Kok suggest. These other weevil species attack the thistle in its rootcrowns, flower and leaf buds, and stems at varying stages in the weed's life cycle.

In summing up, Drea says, "Weeds have different personalities. So do their predators. Years of basic taxonomic studies and greenhouse tests must determine the characteristics of each to be sure the weed is a true host of the insect agent and that the insect won't divorce itself from the target host in favor of a domesticated mate. For example, Japanese beetle would never have been considered. It certainly feeds on the foliage of many weeds, but it also has an appetite for corn, roses, potatoes, and scores of other economically valuable crops and plants."

The ongoing weevil-versus-musk-thistle story seems to be leading to a happy ending. A growing number of farmers, ranchers, state and federal scientists, officials, and county extension agents are helping to spread the head weevil into areas of musk thistle infestation. In Nebraska, the weevil is established in at least 24 counties for sure and probably in infestations throughout much of the state.

"The more places it goes, the better are its chances for survival and effective control of the thistle," Drea says. "Nature can wait centuries—we cannot."

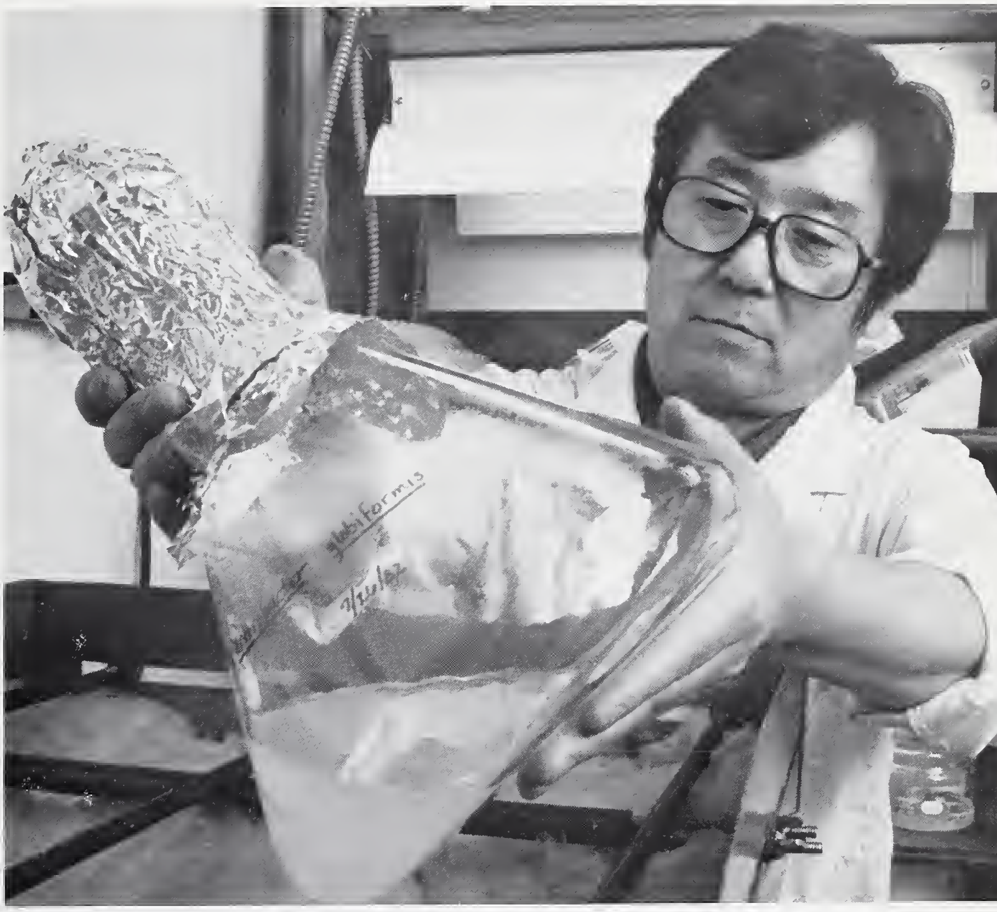
John J. Drea, Jr., is located at the Beltsville Agricultural Research Center-West, Bldg. 005, Beltsville, Md. 20705. Lloyd A. Andres is located at the University of California Gill Tract, 1050 San Pablo Ave., Albany, Calif. 94706. Paul H. Dunn is located at the Biological Control of Weeds Laboratory in Rome, Italy, c/o American Embassy, APO 09794, New York City. Kenneth E. Frick is at the Delta States Research Center, P.O. Box 225, Stoneville, Miss. 38776. L. T. Kok is at the Dept. of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Va. 24061. M. K. McCarty is at the Dept. of Agronomy, University of Nebraska, Lincoln, Nebr. 68503. N. E. Rees is at the USDA Rangeland Insect Laboratory, University of Montana, Bozeman, Mont. 59717. Suzanne Batra is located at the Beltsville Agricultural Research Center-East, Bldg. 417, Beltsville, Md. 20705—(By Robert E. Enlow, Peoria, Ill.) ■

Debittering Processed Navel Orange Juice

Using bacteria he found in soil outside the ARS Fruit and Vegetable Laboratory, Pasadena, Calif., chemist Shin Hasegawa has developed a method to debitter orange juice that has become bitter during processing.

Bitterness in processed navel orange juice—and other citrus fruit juices to a lesser degree—comes from an originally nonbitter substance in the oil in the peel. The substance is called limonoate A-ring lactone, and when it is released in the juicing process it becomes limonin, which is intensely bitter even in small amounts. The same bitterness can occur in the home when navel oranges are squeezed and the juice allowed to stand for a time before being served. Fresh orange juice or whole fruits are not affected.

Hasegawa tested many soil-borne bacteria sent to him by scientists worldwide, until he found *Arthrobacter globiformis* on the laboratory grounds. These bacteria, he found, could use limonin as their food source by manufacturing two enzymes to break it down into a form they could metabolize. One of the enzymes turns limonin into limonoate A-ring lactone, reversing the reaction that goes on during processing. The other enzyme turns limonoate A-ring lactone into a stable, nonbitter compound.



Chemist Shin Hasegawa examines the growth of *Arthrobacter globiformis* bacteria in a medium of limonoate, a substance in navel orange peel that becomes bitter when released in the juicing process. (0882X891-8A)

Hasegawa, after growing the bacteria, encapsulates them in plastic-like resin beads and puts the beads in a long tube container. By running the bitter navel orange juice through the container, exposing it to the enzymes, the juice is debittered. Nothing is added nor is there any change in any of the other constituents in the juice. The process works much like home water softeners.

The advantage of this new process over traditional processes—the use of isolated enzymes—is that encapsulating the debittering enzyme system in resin beads makes it more effective and more stable than the isolated enzymes. More important, the enzymes are so stable that the system can be used 15 to 20 times before effectiveness is lost.

Since the two enzymes work in different ways, the method could be used on newly processed juice to prevent limonin from forming, or the juice could be stored and the method used later to debitter the limonin that formed after processing.

Hasegawa is continuing research to find bacteria which produce limonin-metabolizing enzymes when grown on food sources other than limonin. He is looking for food sources more readily available for large-scale processing. He recently isolated bacteria that grow in glucose, galactose, or fructose to produce the two enzymes.

Shin Hasegawa is located at the Fruit and Vegetable Chemistry Laboratory, 263 So. Chester Ave., Pasadena, Calif. 91106.—(By Paul Dean, Oakland, Calif.) ■

Hasegawa encapsulates the bacteria in resin beads. When navel orange juice is poured through the beads, it is debittered by enzymes produced by the bacteria. (0882X893-30)

Tracking the Black Cutworm

Entomologist William B. Showers holds a sticky, pheromone-baited trap which has caught male black cutworm moths. Iowa Extension personnel monitor traps like these statewide to help Showers predict when farmers are likely to find cutworm eggs in their fields. (782X741-30)

The way ARS research entomologist William B. Showers figures it, the black cutworm moth comes north with the robins after wintering in warmer places. The pregnant moths leave their eggs in weeds, grass, and dead plant materials, where they hatch and feed. When farmers turn under last year's corn or soybean residues, the cutworms are left with a bare cupboard until the corn comes up. And by then they are very hungry.

"With more farmers turning to reduced tillage to save fuel and reduce erosion, we may be creating an ideal situation for the black cutworm, which we believe is coming north from Texas, Louisiana, and Mississippi," says Showers, who is with the Corn Insects Research Unit, Ankeny, Iowa.

His research has led to a statewide head count of black cutworm moths, beginning around the end of March. Iowa Cooperative Extension agents put out sticky insect traps baited with the cutworm's own sex pheromone. When the counts come in, Showers interprets the numbers of moths and calculates how far north they are and how rapidly they are moving. Extension climatologist S. Elwynn Taylor figures in the weather information, and then Extension entomologist Harold J. Stockdale and Showers can make a fairly good prediction about when farmers will find cutworm eggs in their fields.

"Timing is critical because the black cutworm larva feeds on the leaves when corn is small and that is when they are capable of doing the most damage. After the corn plant grows four or five leaves, few plants will be damaged and the surviving plants will compensate for the losses. In dry weather, the cutworm moves down and will cut stalks at or below the soil surface and out of reach of sprays and baits," Showers says.

There are two ways to deal with the problem, according to Showers. One way is to work up the corn ground, covering up the cutworm's food, and then put off planting for about 2 weeks. Then, by the time the corn comes up, maybe 10 days after plant-

To determine levels of damage at different stages of plant growth, Showers and Iowa State University graduate student L. Von Kaster place cutworm larvae on test plots of corn seedlings. Aluminum barriers keep the test cutworms in and others out. (0782X738-11A)

ing, all the cutworms will have starved to death. The problem with this approach is that the later the corn is planted, the less time it has to grow a good crop, so most farmers will not want to wait.

Another method is to draw the insects to a bait that is laced with insecticide. "We found from testing seven different baits that cutworms like bran, grape, and apple-grape mixture the best. Those three materials came out way ahead of apple-bran, cottonseed hulls, citrus, and cornmeal in our cutworm taste tests," Showers says. Using this information, some commercial firms now offer bran bait materials with a lethal dose of insecticide added.

Showers' research results show that one hardworking cutworm in 3 feet of corn row translates into a loss of around 45 bushels of corn per acre at harvest time if the cutworm is there and hungry when the corn emerges.

The scientists and two Iowa State University graduate students, L. Von Kaster and Phillip G. Mulder, placed black cutworm larvae of plant-cutting size on corn plots at three stages of plant growth: emergence, second-leaf, and fourth-leaf. They applied larvae at four rates: one, two, three, and four larvae per meter of corn row. They used 8-inch aluminum sheeting around the plots to keep their own cutworms in and others out.

Cutworms caused most damage and yield loss during the emergence through the first-leaf stage of plant development, Showers says. Four working cutworms per meter of row at emergence produced an average yield loss of 77.9 bushels per acre.

"As the corn got older it took more cutworms to cause yield losses. So, growers should be scouting their fields shortly after planting and should apply control measures early enough to prevent cutworm attack during the critical first-leaf stage," Showers says.

Scouting corn fields is complicated, however, by the fact that cutworms hole up during the day and do most of their feeding at night. Mild weather and weedy field conditions improve the cutworm's chances, too. Those favorable conditions in 1981 produced the worst

Inside a test plot, Showers inspects seedling corn for cutworm damage. Corn is most vulnerable to cutworms in the emergence through first-leaf stages. (782X738-32a)

The smallest larva (upper left), and the elongated and curled larvae are the stages of black cutworm development most destructive to plants. By the pupal stage (bottom)—from which the moth emerges—the damage has already been done. (0782X736-16)

cutworm year Iowa ever had, with more than 90 percent of Iowa's fields infested.

Without scouting and early treatment, control becomes a crisis rescue operation—usually when the plants are already up 8 or 10 inches and most of the damage has already been done.

With a cutworm tracking and alert system such as Showers and Taylor have initiated in Iowa, however, farmers will know when black cutworm eggs are hatching in their fields so that they can plan to control them at an early stage.

Armon J. Keaster, University of Missouri entomologist, and Donald E. Kuhlman, Extension entomologist with the University of Illinois, are running similar survey programs in their states, Showers says.

William B. Showers is located at the Corn Insects Research Laboratory, Ankeny Research Farm, RR #3, Box 45B, Ankeny, Iowa 50021.—(By Ray Pierce, Peoria, Ill.) ■

Soybean Hay? No Way, Say Jerseys

Jersey cows faced with a large bale of coarse, stiff-stemmed soybean hay cast predictably baleful eyes on the menu. Cows are accustomed to eating small stems in hay, but not pencil-sized stems firmly anchored into the bale and protruding like the quills of a porcupine.

The "porcupine effect" was reported by ARS and University of Tennessee dairy scientists as part of an ongoing study to evaluate field covers for large, round, high-density bales of alfalfa-orchardgrass hay. Because the original mixed crop was destroyed by rain, the researchers harvested and baled soybeans from a nearby field.

Soybeans must stand in the fields for weeks waiting for the combine; therefore, plant breeders have bred stiff, erect stems into most varieties. However, these stems create problems when the soybeans are diverted to emergency hay, says ARS research animal scientist Harold D. Baxter.

Compactness of high-density bales is desirable because the bales resist moisture penetration, but it can make the bale more difficult for the cows to tear apart. If the hay is coarse the problem is compounded, says Baxter.

Baxter and his colleagues say the green leafy appearance of soybean hay coupled with 15 percent crude protein content was a plus. The minus was that the cows couldn't eat the coarse stems. The soybean hay could have provided substantial nutrition if the cows had been able to separate and eat only the leaves and small stems. Such feeding may be wasteful in terms of volume but not necessarily wasteful of nutrients, highly important to dairy animals.

When the high-density, large, round bale was installed in a self-feeding manger, new problems occurred. In previous studies with alfalfa-orchardgrass hay, self-feeding mangers reduced waste. But with soybean hay, the cows rejected the quill-like stems at the base of the bale, so the stems accumulated, creating a barrier to feeding. As the pile of stems grew and formed a cover, cows were forced to reach higher into the feeding manger, looking for better hay. This eventually left a core of uneaten hay in the center of the manger, surrounded by the stem barrier. By the fourth day of feeding, the large bale had collapsed to an apparent pile of coarse straw.

But when researchers removed the cover of stems, they found edible hay that amounted to roughly one-third of the original bale, a significant waste by any standard.

Furthermore, since dairy cows normally require high-quality forage, the Jerseys' milk production suffered on the stemmy hay diet.

Large-baled soybean hay may work well for nondairy breeds of cattle, says Baxter, but in the feeding trial with Jersey milk cows, the hay was so unsatisfactory that the trial was discontinued after 6 days.

Harold D. Baxter worked with Superintendent J. R. Owen at the cooperative ARS-Tennessee Dairy Experiment Station, Rt. 6, Lewisburg, Tenn. 37901. Collaborating scientists were B. L. Bledsoe and M. J. Montgomery, located at the University of Tennessee, Knoxville, Tenn. 37901.—(By Peggy Goodin, New Orleans, La.) ■

Rhizoctonia Control Still Elusive

Sugarbeet losses to rhizoctonia root rot are increasing annually in the United States. Despite efforts by ARS scientists at Fort Collins, Colo., to discover some of the fungus disease's secrets, losses continue to mount.

However, two suspected agents that had been thought to affect the disease's severity—sulfur fungicides and herbicides—have been eliminated. Some growers thought sulfur decreased losses and that herbicides increased them.

Even though herbicides apparently do increase disease severity in other agricultural crops, scientists at the Crops Research Laboratory on the Colorado State University campus could find no herbicide-rhizoctonia connection.

Plant pathologist Earl G. Ruppel, geneticist Richard J. Hecker, and plant physiologist Edward E. Schweizer examined seven herbicides, two applied before planting and five applied after seedlings emerge. All except one are herbicides commonly used to control weeds in beet fields. The remaining chemical is an experimental herbicide that has not been approved by the U.S. Environmental Protection Agency for use on beets. All were applied at recommended dosages.

Ruppel and Hecker also found that sulfur fungicides do not control rhizoctonia. Some growers in Colorado had reported to the scientists that they thought rhizoctonia severity decreased slightly when they used sulfur as a soil amendment.

"Our 2-year test shows that sulfur in itself does not help control rhizoctonia. We applied a 55-percent sulfur emulsion at the recommended rate of 6 pounds per acre and at the higher rates of 12 and 30 pounds per acre," says Ruppel.

Two different application methods were used: broadcast before planting and mixed into the soil; and 4-inch bands mixed. Neither showed any effect. The field where the experiments were conducted was highly infected with rhizoctonia fungus.

Earl G. Ruppel, Richard J. Hecker and Edward E. Schweizer are located at the Crops Research Laboratory, Colorado State University, Fort Collins, Colo. 80523.—(By Dennis Senft, Oakland, Calif.) ■

Feeding Lambs Alfalfa-Brome

(877W879-31)

Average daily gains are nearly identical when lambs graze alfalfa or a mixture of alfalfa-smooth bromegrass that is predominately alfalfa.

Daily gains on alfalfa-brome decline when the grass provides more than half of the total forage available.

This difference disappears, however, when lambs also are fed grain free choice, as seen in 3-year studies by the Agricultural Research Service and the University of Minnesota.

ARS agronomist Gordon C. Marten and university ruminant nutritionist Robert M. Jordon are studying lamb production as affected by forage to develop lower cost cropping systems and to reduce erosion.

Beyond that, the sheep serve as ruminant pilot animals in the studies to detect biologically significant advances in forage quality and cropping systems. Sheep are more sensitive to most dietary changes than cattle, Marten says. If something biologically significant is determined with sheep, it is then tested on cattle.

"U.S. sheep numbers declined from about 25 million to half that from 1965 to 1979," Marten recounts. "Since then they have shown slight increases of 1 to 2 percent each year.

"That's encouraging because, as you may know, sheep get 90 percent of their feed nutrients on the average from forages, and sheep are often raised in areas that are subject to considerable soil erosion.

"If we can develop forage-oriented cropping systems that appeal to present and potential sheep producers," Marten says, "then we may be able to reduce the cost of producing sheep, increase production and consumption of lamb, and create markets for forages that will increase water absorption and protect soils from erosion. But that depends on consumer acceptance of lambs, and more specifically acceptance of forage-fattened instead of grain-fattened lamb."

Marten says the ARS-Minnesota research supports the continued feeding of grain to lambs on pure legume pastures and legume-grass mixtures for maximum and most cost-effective weight gains. Lambs and other ruminant animals cannot consume as much energy from grass-legume mixtures. However, there is the problem of bloat among sheep and other ruminants when pastured on pure alfalfa, he says. "If we could come up with a bloat-free alfalfa, such as the Canadian Department of Agriculture is attempting to breed, then we would recommend grazing pure alfalfa more often."

Hampshire-Columbia-Finn cross lambs were offered four alternative rations in the study: alfalfa-brome pasture, pure alfalfa pasture, alfalfa-brome pasture plus free choice grain, and pure alfalfa pasture plus free choice grain. The pelleted grain mixture was 60 percent corn, 25 percent oats, 13 percent beet pulp, and trace minerals. Lambs grazing without grain received trace minerals free choice.

Average daily gains varied from a low of 0.21 pound on alfalfa-brome without grain to 0.51 pound both on rations of alfalfa-brome with grain and alfalfa with grain.

When forage was the only source of energy, average daily gains of lambs were significantly greater on alfalfa (0.33 pound) than on alfalfa-brome (0.22 pound) during 1979. Lamb gains declined, Marten says, when grass became more than half (58 percent) of the total available forage. In 1977 the alfalfa-brome pastures were mostly alfalfa and in 1978 more than half alfalfa.

When grass makes up more than half of the forage, intake of forage by lambs reaches its lowest rate. And, from a cost-benefit standpoint, it is then, Marten says, that feeding grain concentrates provides the greatest benefit.

"That doesn't mean that we didn't get a good cost-benefit by feeding grain with alfalfa alone. We did. It does mean that when grain is not fed, the best economic response occurs when you have a high-quality forage like alfalfa," he explains.

Marten explains further that because grass contains more fibrous cell walls than does alfalfa, grass moves more slowly through the digestive tract. This means that less grass forage can be consumed, fewer nutrients are made available for growth over a period of time, and lambs reach market weights at older ages than those fed alfalfa. Grain-fed animals consume more nutrients than those fed only pasture forages, and these animals reach market weight soonest.

As a result, he says, "Meat from these younger animals is more tender and more marbled with fat than is meat from forage-fattened animals. In Australia and New Zealand, lamb producers simply market forage-fed lambs at a young age," Marten says, "and the meat has nationwide acceptance. We hope this degree of acceptance can be achieved in the United States."

Gordon C. Marten and Robert M. Jordan are located at the Department of Animal Science, University of Minnesota, St. Paul, Minn. 55108.—(By Robert E. Enlow, Peoria, Ill.) ■

Establishing Zoysiagrass by Seed

Zoysiagrass is a valuable warm-season turfgrass prized for its thick mat and resistance to drought, disease, and weeds. Zoysia's use, however, has been limited because it could not be adequately established by seeding.

Also known as Korean or Japanese lawngrass, zoysia is well adapted to conditions in much of the United States. Its slow growth and tolerance to many stresses make it one of the least expensive turfgrasses to maintain. But establishing zoysiagrass has required drilling small zoysia plants, or plugs, into the ground every 6 to 12 inches. These plugs take 2 years or longer to cover an area completely.

The technique for growing zoysia by seed was first suggested by Doyi Yeam, a plant physiologist from Seoul National University, Korea, on sabbatical at ARS's Agricultural Research Center in Beltsville, Md.

Yeam, Beltsville research agronomist Jack Murray, and Herb Portz of Southern Illinois University found that more than 90 percent of zoysia seed would germinate in 6 days if soaked in a 34 percent potassium hydroxide (KOH) solution for 25 minutes and exposed to 48 hours of low-intensity light. Previously, it took 6 weeks to achieve 30 percent germination.

The KOH solution breaks the seed coat and eliminates a growth-inhibiting enzyme, Murray explains. The low-level light stimulates rapid and uniform germination.

Better still, zoysia planted by seed spreads twice as quickly as zoysia planted by plugs. In Murray's tests, 67 percent of the treated seed area was covered by grass after only 3 weeks. Untreated seed, by comparison, had covered only 3 percent of the plots. Murray also discovered that 1 to 2 pounds of seed applied per 1,000 square feet would completely fill an area in 6 to 8 weeks.

Jack Murray is located at the Beltsville Agricultural Research Center, Bldg. 001, Room 333, Beltsville, Md. 20705. Herb Portz is located at Southern Illinois University, Carbondale, Ill. 62901.—(By Andy Walker, Beltsville, Md.) ■

Slurpers Not a Germination Aid

Undoubtedly there exists an abundant variety of uses for water-absorbing, starch-based hydrophilic polymers, but ARS tests show that enhancing rangeland grass plantings is not one of them.

Hydrophilic polymers, popularly dubbed "super slurpers" (see *Agricultural Research,* June 1975, p. 7), delayed and reduced rangeland grass seed germination and emergence in tests conducted by ARS agronomist Fred B. Gomm, Logan, Utah.

Gomm's findings contradict recent commercial advertisements promoting slurpers as grass seed germination aids.

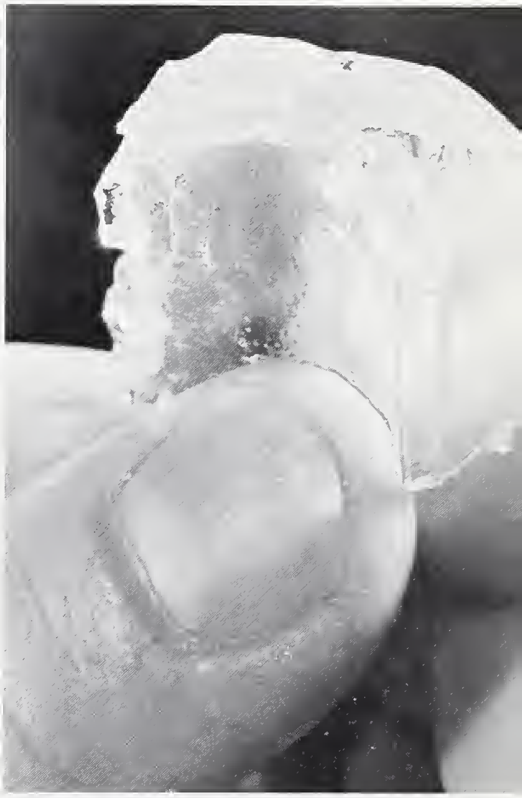
The addition of a slurper material capable of absorbing 400 times its weight in water did, under certain conditions, extend the green growth period of wheatgrasses and improve the soil's tilth and water-holding characteristics throughout a year of drying and wetting in Gomm's tests. However, the water-absorbing material did nothing to enhance the emergence of the seedlings.

Warns Gomm, "During an extended drought, the incorporation of hydrophilic polymers might actually intensify aridity by absorbing and holding moisture near the soil surface where it can be readily evaporated."

Germination and seedling establishment are the most critical stages of plant development for rangeland grasses. Says Gomm, "Rangeland seedling failures occur primarily because of inadequate soil moisture during the first 6 weeks after germination."

Efforts to concentrate moisture near germinating seeds to insure seedling establishment, such as deep furrow drilling, pitting, mulching, and water harvesting, have had limited success. The use of soil additives and conditioners has not fared well at all.

In Gomm's tests, three species of wheatgrass—Nordan, Oahe and a new hybrid called RS-1—were planted in 72 pots of a sandy loam-peatmoss soil mix. The pots were divided into four groups of 18, with one group containing no slurper material and the remaining groups containing 0.5, 1.0, and 1.5 percent, respectively. An additional 18 pots containing only slurper material were also tested.



A tiny flake of an incredibly water-absorbent polymer, popularly called a "slurper," swells into a semisolid chunk of water. Recent tests show that the slurper as a soil amendment does not enhance rangeland grass seedling germination. (0975R1878-20A)

All pots were subjected to a series of wetting and drying treatments. The 0.5 percent mixture of slurper material was relatively stable in the soil. When emerged seedlings were rewatered for 1 year, to determine long-term effects of hydrophilic polymers on plant growth and soil physical characteristics, the 0.5 percent mixture made sufficient water available to extend the green growth period of all the grasses.

Gomm believes that a 0.5 percent hydrophilic polymer or super slurper mixture offers merit as a soil conditioner, but not as a grass seed germination aid.

Fred B. Gomm is located at Utah State University, UMC 63, Logan, Utah 84322.—(By Lynn Yarris, Oakland, Calif.) ■

Radar Tracks Insect Migrations

Meteorologist John Westbrook (center) adjusts a surveying instrument to track a weather balloon as agricultural engineer Wayne W. Wolf (right) follows it visually and entomologist Sammy D. Pair (left) takes notes. Atmospheric data will be correlated to the radar tracks of insects obtained using the antenna on the trailor. (0682X649-22)

Radar is revealing some curious habits of insects as they migrate en masse.

Scientists have long known that insects move vast distances in mass numbers high in the atmosphere, but only recently have they had the technology to prove it. Now a team of ARS scientists is using radar to measure when insects fly, how high they go, and how long they stay in the air.

To date, the research team based at Tifton, Ga., has established three findings. First, mild wind convergences can concentrate insects into lines several miles wide and many miles long. Second, night-flying insects often fly in layers if temperature and wind conditions are favorable. As many as five layers of insects have been detected at one time. And third, most insects detected by radar in Georgia tend to fly uniformly rather than swarm. Densities are greatest a few hours after sunset.

"There's a big ocean up there, transporting insects," says Wayne W. Wolf, an agricultural engineer on the research team, who uses the radar to collect data.

Sammy D. Pair, an entomologist for the team, fits the information from the radar to the nighttime behavior of the insects in the early phases of their flights. John Westbrook, a meteorologist, relates the information to the wind and temperature conditions aloft, provided by the latest weather charts and balloons.

"The radar right now is not capable of discriminating between specific insects," says Wolf, but it can give estimates of total numbers in the air.

The equipment is trailer-mounted and taken to various field locations. Wolf directs the radar beam to detect insects at various altitudes above the ground. Minimum altitude may be from 3 to 100 meters (about 10 to 325 feet) depending on such features as ground cover and terrain. The maximum detection range varies according to the size of the insect: a corn earworm moth, for example, can be tracked a distance of about 2 kilometers (about 1¼ miles).

Insects detected by radar are too big to be supported by air currents alone, so they must actively fly to stay aloft, the scientists have found. Even so, it may be advantageous to the insects to get to higher altitudes, where the weather system helps to carry them. The research team would like to find

out if insects modify their behavior in response to changes in air pressure, temperature, and winds.

If enough information can be gathered on insect responses to weather changes, the research team says, then scientists may be able to predict mass movements in air currents. For example, other scientists reported trapping corn earworm moths in central Texas and southern Arkansas before local moths had emerged from overwintering. These insects probably came from south Texas and Mexico. Wolf cites the jet streams of "tornado alley" in the Midwest and the Southern Great Plains as ideal transporters of insects.

An important economic consequence of insect migration is the continuous reinfestation of thousands of acres of previously treated farmland. The scientists suggest that the information from this study may be applied to pest control strategies to improve investments in costly chemicals, equipment, and labor.

Wayne W. Wolf, Sammy D. Pair, and John Westbrook are located at the Grain Insect Research Laboratory, Georgia Coastal Plains Experiment Station, Tifton, Ga. 31793.—(By Peggy McCormick Adams, Washington, D.C.) ■

Top: Appearing as blips on a radar screen, high-flying insects are tracked by Wolf. The radar images reveal insect altitudes, concentrations, and range. (0682X649-34)

Above: Pair examines one of many traps used to count fall armyworms. Data from traps help the research team measure seasonal insect population fluctuations and correlate them with the radar data. (0682X650-15)

Range Forage Sampling Found Reliable

Questions about the reliability of a weight-estimate, double-sampling procedure to measure range forage are being answered by ARS range scientist Jonathan D. Hanson. He has tested the procedure, which has been used by researchers for about 35 years, and found it reliable, even though vegetation samples are collected by different persons.

Having accurate information on amount of range vegetation is one of the major factors that insures efficient red meat production. Ranchers cannot just turn their cattle loose on ranges and hope they get enough to eat. They must know with accuracy how many cattle each acre of range can support, or in many areas of the West, how many acres are needed for each animal.

Because it is impossible to clip a whole pasture or vast acreages, persons taking samples place on the range a frame approximately 2 feet by 1 foot and estimate how much the plants within the frame will weigh. They then clip and weigh the plants, and compare results to their estimates. After a few days, Hanson says, samplers develop a knack for "eyeballing."

Hanson says that differences among persons taking samples is not significant once they have been adequately trained. He analyzed data collected by people working from 1971 through 1975 at the Central Plains Experimental Range near Nunn, Colo.

"Right now, the sampling method is for researchers, but we are working on a mathematical formula, including many other contributing factors such as precipitation, temperature, insect damage, and wildlife grazing, for ranchers to help them make better management decisions. These decisions would be based more on science than educated guesses. This should help remove some of the uncertainty in beef production," says Hanson, who cooperated with biologist George Van Dyne (now deceased), Colorado State University, Fort Collins, on the study.

Jonathan D. Hanson is located at the High Plains Grasslands Research Station, 8404 Hildreth Rd., Cheyenne, Wyo. 82001.—(By Dennis Senft, Oakland, Calif.) ■

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Agrisearch Notes

The Costs of Cottonseed Flour Production

The cost factor in processing glanded cottonseed into edible, 65-percent-protein flour by an air classification process has been evaluated by researchers at the ARS Southern Regional Research Center in New Orleans, La.

Chemical engineer Kenneth M. Decossas reports that the study was initiated because the physical and functional characteristics of the cottonseed flour, a protein concentrate, make it attractive for use at a 10- to 20-level of enrichment in such food formulations as meat extenders, baked products, and snack foods. The flour also meets the toxic-free standards of both the U.S. Food and Drug Administration and the Protein Advisory Group of the United Nations.

Decossas developed the engineering prospectus in collaboration with food technologists Ranjit S. Kadan and Donald W. Freeman, chemical engineer James J. Spadaro, and chemist George M. Ziegler, Jr. Their plan covers the sequences of operation and processing conditions and resulting yield of flour and coproducts (oil, coarse flour fractions, hulls, and fine meats) at hypothetical industrial-scale plants in Lubbock, Tex., and Greenwood, Miss., two major centers of the cottonseed processing industry.

Capital costs, itemized manufacturing costs and general expenses, and selling prices were projected for annual productions of up to 17.5 million pounds of flour and 35 million pounds of flour at these plants, which would have daily capacities of 25 tons and 50 tons of flour, respectively.

The cost analysis is mostly based on data taken during simulated continuous processing in the pilot plant at the Southern Regional Research Center and at application test centers of equipment manufacturers.

The research team estimates that fixed capital investments for a 25-ton-per-day plant would be $4 million, and for a 50-ton-per-day plant, $5.5 million. Production of edible flour from prime-quality cottonseed kernels would cost as little as 15.8 cents per pound and the selling price of the flour, allowing for the value of coproducts, would be as low as 23.6, 18.9, and 16.5 cents per pound for payout periods of 2, 3, and 4 years, respectively. The flour's price would be competitive with the price of soybean protein concentrate.

The engineering prospectus also includes a detailed equipment list, energy requirements, and tables of profitability. The study is available upon request from Decossas.

Kenneth M. Decossas is located at the Southern Regional Research Center, P.O. Box 19687, New Orleans, La. 70179.—(By Neal Duncan, New Orleans, La.) ■

The Round Bale—Stable Fly Connection

Farmers who store large round bales of hay in a way that minimizes spoilage loss may also minimize the number of stable flies around their livestock.

In the summer, bloodsucking stable flies may reduce cattle's milk production and weight gain and also predispose the animals to infections.

Researchers of the ARS Biological Control of Insects Research Laboratory, Columbia, Mo., and the University of Missouri-Columbia found stable fly larvae or pupae in the undersurface of most bales stored outdoors in a survey of 12 sites in central Missouri. Exceptions were bales that were wrapped in plastic or stored on crushed rock, said ARS entomologist Gustave D. Thomas.

The survey was conducted to help the scientists develop pest management programs against flies affecting pastured cattle.

Bales in an advanced state of decay during the wet summer appeared less attractive to stable flies than actively fermenting bales that were only a few months old.

Aligning bales on a north-to-south axis to permit sunlight penetration under rounded edges, moving bales to well-drained sites and leaving a spacing between bales to promote drainage will help reduce spoilage and stable fly breeding sites, Thomas says.

In another survey, ARS entomologist Philip J. Scholl at Lincoln, Nebr., observed that uncovered silage piles were an important overwintering site for stable flies. Most stable fly maggots were within about 2 feet of moist silage and soil along the edges of the piles.

Gustave D. Thomas is located at the Biological Control of Insects Research Laboratory, Research Park, P.O. Box A, Columbia, Mo. 65205.—(By Ben Hardin, Peoria, Ill.) ■